CLAIMS

Having thus described the aforementioned invention, we claim:

1.   An apparatus for automating cross calibrations of plant instruments, said apparatus comprising:

5   a processor in communication with a data storage system, said data storage system being a part of a plant monitoring system, said processor programmed to execute a process including

loading a data set from said data storage system, said data set including a plurality of measured process values from a plurality of
10   instruments, said plurality of instruments including at least one redundant instrument, said plurality of measured process values including a plurality of temperature measurements obtained during isothermal conditions,

selecting for analysis a set of data from said data set,

removing a set of deviating data from said set of data,

15   analyzing a set of remaining data for cross-calibration, and

recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data.

2.   The apparatus of Claim 1 wherein said process step of loading a data set includes selecting a file, loading a set of RTD data, calculating RTD averages
20   from said set of RTD data, loading a set of thermocouple data, calculating thermocouple averages from said set of thermocouple data, and matching timeslices.

3.   The apparatus of Claim 1 wherein said process step of selecting for analysis includes selecting said set of data consisting of a plurality of data points
25   that fall within a specified range and calculating an upper temperature and a lower temperature for at least one region.

4.   The apparatus of Claim 1 wherein said process step of removing said set of deviating data includes calculating an average narrow range standard deviation value, calculating a fluctuation standard deviation value of average narrow range fluctuations, rejecting a timeslice for said fluctuation standard deviation outside a specified range, and matching thermocouple times to RTD times.

5.   The apparatus of Claim 1 wherein said set of data includes a set of RTD data and a set of thermocouple data, said process step of analyzing said set of remaining data includes calculating a set of RTD deviations from said set of RTD data, calculating an average value and a standard deviation value from said set of RTD deviations, calculating a set of thermocouple deviations from said set of thermocouple data, and calculating an average of said set of thermocouple deviations.

6.   The apparatus of Claim 1 wherein said process step of recalibrating a deviating instrument includes calculating new coefficients for said deviating instrument.

7.   The apparatus of Claim 1 wherein said process step of recalibrating a deviating instrument includes calculating a recalibration uncertainty value for said deviating instrument.

8.   The apparatus of Claim 1 wherein said process step of recalibrating a deviating instrument includes calculating resistance versus temperature for said deviating instrument, calculating new coefficients for said deviating instrument, producing a recalibration curve, and calculating a recalibration uncertainty value.

9.   The apparatus of Claim 1 wherein said process executed by said processor further includes providing a user interface for interacting with an operator of said processor.

10.   An apparatus for automating cross calibrations of plant instruments, said apparatus comprising:

a processor in communication with a data storage system, said data storage system being a part of a plant computer system, said processor programmed to execute a process including:

loading a data set from said data storage system, said data set including a plurality of measured process values from a plurality of instruments,

selecting for analysis a set of data from said data set,

removing a set of deviating data from said set of data,

analyzing a set of remaining data for cross-calibration of said plurality of instruments, and

recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data, said process step of recalibrating including calculating new coefficients for said deviating instrument and calculating a recalibration uncertainty value for said deviating instrument.

11.   An apparatus for automating cross calibrations of plant instruments, said apparatus comprising:

a processor in communication with a data storage system, said data storage system being a part of a plant computer system, said processor programmed to execute a process including:

loading a data set from said data storage system, said data set including a plurality of measured process values from a plurality of instruments, said plurality of instruments including at least one redundant instrument, said plurality of measured process values obtained during equilibrium conditions,

selecting for analysis a set of data from said data set,

removing a set of deviating data from said set of data,

analyzing a set of remaining data for cross-calibration of said plurality of instruments, and

5   12.   An apparatus for automating cross calibrations of plant instruments, said apparatus comprising:

a processor in communication with a data storage system, said data storage system being a part of a plant computer system, said processor programmed to execute a process including:

10   loading a data set from said data storage system, said data set including a plurality of measured process values from a plurality of instruments,

selecting for analysis a set of data from said data set, said set of data consisting of a plurality of data points that fall within a specified range,

15   analyzing a set of remaining data for cross-calibration of said plurality of instruments, and

recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data, said process step of recalibrating including calculating new coefficients for said deviating
20   instrument and calculating a recalibration uncertainty value for said deviating instrument.

13. An apparatus for automating cross calibrations of plant instruments, said apparatus comprising:

a processor in communication with a data storage system, said data storage system being a part of a plant computer system, said processor programmed to

5 execute a process including:

loading a data set from said data storage system, said data set including a plurality of measured process values from a plurality of instruments,

selecting for analysis a set of data from said data set, said set of data

10 including a set of RTD data and a set of thermocouple data,

removing a set of deviating data from said set of data, and

analyzing a set of remaining data for cross-calibration of said plurality of instruments, said process step of analyzing further including calculating a set of RTD deviations from said set of RTD data, calculating an

15 average value and a standard deviation value from said set of RTD deviations, calculating a set of thermocouple deviations from said set of thermocouple data, and calculating an average of said set of thermocouple deviations.

14. An apparatus for automating cross calibrations of plant instruments,

20 said apparatus comprising:

a processor in communication with a data storage system, said data storage system being a part of a plant computer system, said processor programmed to execute a process including:

loading a data set from said data storage system, said data set

25 including a plurality of measured process values from a plurality of instruments,

selecting for analysis a set of data from said data set,

removing a set of deviating data from said set of data, and

analyzing a set of remaining data for cross-calibration of said plurality of instruments.

15. The apparatus of Claim 14 wherein said process step of loading a data set includes selecting a file, loading a set of RTD data, calculating RTD averages from said set of RTD data, loading a set of thermocouple data, calculating thermocouple averages from said set of thermocouple data, and matching timeslices.

16. The apparatus of Claim 14 wherein said process step of loading a data set includes calculating at least one average from said data set.

17. The apparatus of Claim 14 wherein said process step of loading a data set includes removing any outliers from said data set before calculating at least one average from said data set.

18. The apparatus of Claim 14 wherein said process step of selecting for analysis includes selecting said set of data consisting of a plurality of data points that fall within a specified range.

19. The apparatus of Claim 14 wherein said process step of selecting for analysis includes calculating an upper temperature and a lower temperature for at least one region.

20. The apparatus of Claim 14 wherein said process step of selecting for analysis includes calculating an upper temperature and a lower temperature for at least one region and separating said set of data into an associated said at least one region.

21. The apparatus of Claim 14 wherein said process step of selecting for analysis includes selecting said set of data consisting of a plurality of data points that fall within a specified range and calculating an upper temperature and a lower temperature for at least one region.

22. The apparatus of Claim 14 wherein said process step of removing said set of deviating data includes calculating an average narrow range standard deviation value, calculating a fluctuation standard deviation value of average narrow range fluctuations, rejecting a timeslice for said fluctuation standard deviation outside a specified range, and matching thermocouple times to RTD times.

23. The apparatus of Claim 14 wherein said process step of analyzing said set of remaining data includes building at least one table of correction deviations.

24. The apparatus of Claim 23 wherein said process step of analyzing said set of remaining data further includes calculating an average for each of said at least one table of correction deviations.

25. The apparatus of Claim 23 wherein said process step of analyzing said set of remaining data further includes calculating a population standard deviation for each of said at least one table of correction deviations.

26. The apparatus of Claim 14 wherein said set of data includes a set of RTD data and a set of thermocouple data, said process step of analyzing said set of remaining data includes calculating a set of RTD deviations from said set of RTD data, calculating an average value and a standard deviation value from said set of RTD deviations, calculating a set of thermocouple deviations from said set of thermocouple data, and calculating an average of said set of thermocouple deviations.

27.   The apparatus of Claim 14 further including, after said process step of analyzing said set of remaining data, a process step of generating a report.

28.   The apparatus of Claim 27 wherein said step of generating a report includes a step of calculating a percent of removed data for at least one region.

5   29.   The apparatus of Claim 27 wherein said step of generating a report includes generating an RTD report.

30.   The apparatus of Claim 27 wherein said step of generating a report includes generating a thermocouple report.

31.   The apparatus of Claim 14 wherein said process executed by said
10   processor further includes, after said step of analyzing, a step of recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data.

32.   The apparatus of Claim 31 wherein said process step of recalibrating a deviating instrument includes calculating new coefficients for said deviating
15   instrument.

33.   The apparatus of Claim 31 wherein said process step of recalibrating a deviating instrument includes calculating new coefficients for said deviating instrument and calculating a recalibration uncertainty value.

34.   The apparatus of Claim 31 wherein said process step of recalibrating
20   a deviating instrument includes calculating resistance versus temperature for said deviating instrument, calculating new coefficients for said deviating instrument, calculating a recalibration curve, and calculating a recalibration uncertainty value.

35. The apparatus of Claim 31 wherein said process step of recalibrating a deviating instrument includes calculating a recalibration curve that includes determining a difference between a measured temperature value and a recalibrated temperature value.

5   36. The apparatus of Claim 31 wherein said process step of recalibrating a deviating instrument includes calculating a recalibration uncertainty value and extrapolating said recalibration uncertainty value to accommodate a limit value.

37. The apparatus of Claim 31 wherein said process step of recalibrating a deviating instrument includes calculating a recalibration uncertainty value and
10   adjusting a limit value to accommodate said recalibration uncertainty value.

38. The apparatus of Claim 14 wherein said process executed by said processor further includes providing a user interface for interacting with an operator of said processor.

39. The apparatus of Claim 38 wherein said step of providing said user
15   interface includes entering a plurality of configuration settings, each of said plurality of configuration settings containing a data value stored by said processor.

40. The apparatus of Claim 38 wherein said step of providing said user interface includes displaying a plurality of configuration settings, each of said plurality of configuration settings containing a data value stored by said processor.

20   41. The apparatus of Claim 38 wherein said step of providing said user interface includes options for printing and displaying a plurality of information associated with said process step of loading a data set.

42.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for selecting a set of user selected data associated with said process step of selecting for analysis.

43.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for displaying and printing a plurality of information associated with said process step of removing said set of deviating data.

44.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for displaying and printing a plurality of information associated with said process step of analyzing said set of remaining data.

45.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for loading a plurality of information associated with a process step of generating a report.

46.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for displaying a plurality of information associated with a process step of generating a report.

47.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for saving a plurality of information associated with a process step of generating a report.

48.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for printing a plurality of information associated with a process step of generating a report.

49.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for displaying and printing a plurality of recalibration

information associated with said process step of recalibrating a deviating instrument.

50.   The apparatus of Claim 38 wherein said step of providing said user interface includes options for saving a plurality of recalibration information associated with said process step of recalibrating a deviating instrument.

51.   An apparatus for automating cross calibrations of plant instruments, said apparatus comprising:

a processor in communication with a data storage system, said data storage system being a part of a plant computer system, said processor programmed to execute a process including:

retrieving a data set from said data storage system, said data set including a plurality of measured process values from a plurality of instruments,

determining at least one average value from said data set,

determining a set of deviating data from said data set, and

determining new coefficients for any one of said plurality of instruments that produce at least one data point in said set of deviating data.

52.   The apparatus of Claim 51 further including, after said step of retrieving said data set, a process step of sorting said data set.

53.   The apparatus of Claim 51 wherein said plurality of instruments includes at least one redundant instrument

54. The apparatus of Claim 51 wherein said plurality of measured process values includes a plurality of temperature measurements obtained during isothermal conditions.

55. A computer system for automating cross calibrations of plant instruments, comprising:

a memory medium for storing program code and a set of computer data;

an input/output unit for communicating with a plant monitoring system, said plant monitoring system acquiring a plurality of measured process values from a plurality of instruments; and

a processing unit programmed to execute a process including:

loading a data set from said plant monitoring system, said data set including said plurality of measured process values from said plurality of instruments,

selecting for analysis a set of data from said data set, and

analyzing a set of remaining data for cross-calibration of said plurality of instruments.

56. The computer system of Claim 55 wherein said process executed by said processing unit further includes, after said step of analyzing, a step of removing a set of deviating data from said set of data.

57. The computer system of Claim 55 wherein said process executed by said processing unit further includes, after said step of analyzing, a step of removing a set of deviating data from said set of data, said step of removing said set of deviating data includes calculating an average narrow range standard deviation value, calculating a fluctuation standard deviation value of average narrow range fluctuations, rejecting a timeslice for said fluctuation standard

deviation outside a specified range, and matching thermocouple times to RTD times.

58. The computer system of Claim 55 wherein said process executed by said processing unit further includes, after said step of analyzing, a step of
5   recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data.

59. The computer system of Claim 55 wherein said process executed by said processing unit further includes, after said step of analyzing, a step of recalibrating a deviating instrument that includes calculating resistance versus
10   temperature for said deviating instrument, calculating new coefficients for said . . deviating instrument, calculating a recalibration curve, and calculating a recalibration uncertainty value.

60. The computer system of Claim 55 wherein said process executed by said processing unit further includes, after said step of analyzing, a step of
15   recalibrating a deviating instrument that includes calculating new coefficients for said deviating instrument.

61. The computer system of Claim 55 wherein said process executed by said processing unit further includes, after said step of analyzing, a step of recalibrating a deviating instrument that includes calculating a recalibration
20   uncertainty value for said deviating instrument.

62. The computer system of Claim 55 wherein said process step of loading a data set includes selecting a file, loading a set of RTD data, calculating RTD averages from said set of RTD data, loading a set of thermocouple data, calculating thermocouple averages from said set of thermocouple data, and
25   matching timeslices.

63. The computer system of Claim 55 wherein said process step of selecting for analysis includes selecting said set of data consisting of a plurality of data points that fall within a specified range and calculating an upper temperature and a lower temperature for at least one region.

64. The computer system of Claim 55 wherein said set of data includes a set of RTD data and a set of thermocouple data, said process step of analyzing said set of remaining data includes calculating a set of RTD deviations from said set of RTD data, calculating an average value and a standard deviation value from said set of RTD deviations, calculating a set of thermocouple deviations from said set of thermocouple data, and calculating an average of said set of thermocouple deviations.

65. An apparatus for automating cross calibrations of plant instruments, said apparatus comprising:

a means for communicating with a plant monitoring system;

a means for processing; and

a means for performing a cross calibration of a plurality of plant instruments.

66. The apparatus of Claim 65 further including a means for recalibrating a deviating instrument.

67. A method in a computer system for automating cross calibrations of plant instruments, the method comprising:

(a) providing for loading a data set from a data storage unit, said data storage unit being a part of a plant monitoring system, said data set including a plurality of measured process values from a plurality of instruments;

(b) providing for selecting for analysis a set of data from said data set;

(c) providing for removing a set of deviating data from said set of data;

(d) providing for analyzing a set of remaining data; and

(e) providing for recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data.

68.   The method of Claim 67 wherein said step of providing for loading a data set includes providing for selecting a file, providing for loading a set of RTD data, providing for calculating RTD averages from said set of RTD data, providing for loading a set of thermocouple data, providing for calculating thermocouple averages from said set of thermocouple data, and providing for matching timeslices.

69.   The method of Claim 67 wherein said step of providing for selecting for analysis includes providing for selecting said set of data consisting of a plurality of data points that fall within a specified range and calculating an upper temperature and a lower temperature for at least one region.

70.   The method of Claim 67 wherein said step of providing for removing said set of deviating data includes providing for calculating an average narrow range standard deviation value, providing for calculating a fluctuation standard deviation value of average narrow range fluctuations, providing for rejecting a timeslice for said fluctuation standard deviation outside a specified range, and providing for matching thermocouple times to RTD times.

71.   The method of Claim 67 wherein said set of data includes a set of RTD data and a set of thermocouple data, said step of providing for analyzing said set of remaining data includes providing for calculating a set of RTD deviations from said set of RTD data, providing for calculating an average value and a standard deviation value from said set of RTD deviations, providing for calculating a set of thermocouple deviations from said set of thermocouple data, and providing for calculating an average of said set of thermocouple deviations.

72.   The method of Claim 67 wherein said step of providing for recalibrating a deviating instrument includes providing for calculating new coefficients for said deviating instrument.

73.   The method of Claim 67 wherein said step of providing for recalibrating a deviating instrument includes providing for calculating a recalibration uncertainty value for said deviating instrument.

74.   The method of Claim 67 wherein said step of providing for recalibrating a deviating instrument includes providing for calculating resistance versus temperature for said deviating instrument, providing for calculating new coefficients for said deviating instrument, providing for producing a recalibration curve, and providing for calculating a recalibration uncertainty value.

75.   The method of Claim 67 further including a step for providing a user interface for interacting with an operator of said processor.

76.   At least one computer programmed to execute a process for automating cross calibrations of plant instruments, the process comprising:

(a) retrieving a data set from a data storage system, said data storage unit being a part of a plant monitoring system, said data set including a plurality of measured process values from a plurality of instruments, said plurality of instruments including a plurality of RTDs;

(b) selecting for analysis a set of data from said data set;

(c) removing a set of deviating data from said set of data;

(d) analyzing a set of remaining data; and

(e) recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data.

77.   The process of Claim 76 wherein said step (a) of loading a data set includes selecting a file, loading a set of RTD data, calculating RTD averages from said set of RTD data, loading a set of thermocouple data, calculating thermocouple averages from said set of thermocouple data, and matching timeslices.

78.   The process of Claim 76 wherein said step (b) of selecting for analysis includes selecting said set of data consisting of a plurality of data points that fall within a specified range and calculating an upper temperature and a lower temperature for at least one region.

79.   The process of Claim 76 wherein said step (c) of removing said set of deviating data includes calculating an average narrow range standard deviation value, calculating a fluctuation standard deviation value of average narrow range fluctuations, rejecting a timeslice for said fluctuation standard deviation outside a specified range, and matching thermocouple times to RTD times.

80.   The process of Claim 76 wherein said set of data includes a set of RTD data and a set of thermocouple data, said step (d) of analyzing said set of remaining data includes calculating a set of RTD deviations from said set of RTD data, calculating an average value and a standard deviation value from said set of RTD deviations, calculating a set of thermocouple deviations from said set of thermocouple data, and calculating an average of said set of thermocouple deviations.

81.   The process of Claim 76 wherein said step (e) of recalibrating a deviating instrument includes calculating new coefficients for said deviating instrument.

82.   The process of Claim 76 wherein said step (e) of recalibrating a deviating instrument includes calculating a recalibration uncertainty value for said deviating instrument.

83.   The process of Claim 76 wherein said step (e) of recalibrating a deviating instrument includes calculating resistance versus temperature for said deviating instrument, calculating new coefficients for said deviating instrument, producing a recalibration curve, and calculating a recalibration uncertainty value.

5   84.   A program storage device readable by a machine, tangibly embodying a program of instructions executable by the machine to perform method steps for automating cross calibrations of plant instruments, said method comprising:

(a) retrieving a data set from a data storage system, said data storage unit being a part of a plant monitoring system, said data set including a plurality of
10   measured process values from a plurality of RTD instruments;

(b) selecting for analysis a set of data from said data set;

(c) removing a set of deviating data from said set of data; and

(d) analyzing a set of remaining data.

85.   The method of Claim 84 further including:

15   (e) recalibrating a deviating instrument, said a deviating instrument being any one of said plurality of instruments that produce at least one data point in said set of deviating data.

86.   The method of Claim 85 wherein said step (e) of recalibrating a deviating instrument includes calculating new coefficients for said deviating
20   instrument.

87.   The method of Claim 85 wherein said step (e) of recalibrating a deviating instrument includes calculating a recalibration uncertainty value for said deviating instrument.

88.   The method of Claim 85 wherein said step (e) of recalibrating a deviating instrument includes calculating resistance versus temperature for said deviating instrument, calculating new coefficients for said deviating instrument, producing a recalibration curve, and calculating a recalibration uncertainty value.

89.   The method of Claim 84 wherein said step (a) of loading a data set includes selecting a file, loading a set of RTD data, calculating RTD averages from said set of RTD data, loading a set of thermocouple data, calculating thermocouple averages from said set of thermocouple data, and matching timeslices.

90.   The method of Claim 84 wherein said step (b) of selecting for analysis includes selecting said set of data consisting of a plurality of data points that fall within a specified range and calculating an upper temperature and a lower temperature for at least one region.

91.   The method of Claim 84 wherein said step (c) of removing said set of deviating data includes calculating an average narrow range standard deviation value, calculating a fluctuation standard deviation value of average narrow range fluctuations, rejecting a timeslice for said fluctuation standard deviation outside a specified range, and matching thermocouple times to RTD times.

92.   The method of Claim 84 wherein said set of data includes a set of RTD data and a set of thermocouple data, said step (d) of analyzing said set of remaining data includes calculating a set of RTD deviations from said set of RTD data, calculating an average value and a standard deviation value from said set of RTD deviations, calculating a set of thermocouple deviations from said set of thermocouple data, and calculating an average of said set of thermocouple deviations.

93. Computer readable media tangibly embodying a program of instructions executable by a computer to perform a method of automating cross calibrations of plant instruments, said method comprising:

(a) retrieving a data set from a data storage system, said data storage unit being a part of a plant monitoring system, said data set including a plurality of measured process values from a plurality of RTD instruments;

(b) selecting for analysis a set of data from said data set;

(c) analyzing a set of remaining data; and

(d) recalibrating any one of said plurality of instruments that produce at least one data point in said set of deviating data.

94. The method of Claim 93 further including, after said step (b) selecting for analysis, a step for removing a set of deviating data from said set of data.

95. The method of Claim 94 wherein said step of removing said set of deviating data includes calculating an average narrow range standard deviation value, calculating a fluctuation standard deviation value of average narrow range fluctuations, rejecting a timeslice for said fluctuation standard deviation outside a specified range, and matching thermocouple times to RTD times.

96. The method of Claim 93 wherein said step (a) of loading a data set includes selecting a file, loading a set of RTD data, calculating RTD averages from said set of RTD data, loading a set of thermocouple data, calculating thermocouple averages from said set of thermocouple data, and matching timeslices.

97. The method of Claim 93 wherein said step (b) of selecting for analysis includes selecting said set of data consisting of a plurality of data points that fall within a specified range and calculating an upper temperature and a lower temperature for at least one region.

98.   The method of Claim 93 wherein said set of data includes a set of RTD data and a set of thermocouple data, said step (c) of analyzing said set of remaining data includes calculating a set of RTD deviations from said set of RTD data, calculating an average value and a standard deviation value from said set of RTD deviations, calculating a set of thermocouple deviations from said set of thermocouple data, and calculating an average of said set of thermocouple deviations.

99.   The method of Claim 93 wherein said step (d) of recalibrating a deviating instrument includes calculating new coefficients for said deviating instrument.

100.   The method of Claim 93 wherein said step (d) of recalibrating a deviating instrument includes calculating a recalibration uncertainty value for said deviating instrument.

101.   The method of Claim 93 wherein said step (d) of recalibrating a deviating instrument includes calculating resistance versus temperature for said deviating instrument, calculating new coefficients for said deviating instrument, producing a recalibration curve, and calculating a recalibration uncertainty value.